Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Marine Occurrence Investigation No. 235
Final

Independent investigation into the crew member fatality on board the Isle of Man registered oil tanker

British Mallard

while berthed in Kwinana, Western Australia

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Independent investigation into the crew member fatality on board the Isle of Man registered oil tanker *British Mallard* while berthed in Kwinana, Western Australia on 27 January 2007.

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Abstract
On the morning of 26 January 2007, *British Mallard* berthed at the BP Kwinana oil refinery jetty, Western Australia, to discharge its cargo.

At about 1750 on 27 January, the ship's engineers attempted to rectify an elevator fault that had been reported earlier in the day. After making some adjustments to the second deck elevator landing door switches, the electrical technician stepped onto the ladder in the elevator shaft. He then asked the second engineer to let the doors close behind him.

Soon after the doors closed, the elevator car travelled upwards and after a few seconds it stopped.

The second engineer could not open the second deck elevator landing doors. He called the third engineer, on his hand held radio, and told him to come to the second deck. The two men tried, unsuccessfully, to open the elevator doors.

The two men then went upstairs and opened the upper deck elevator landing doors. They looked down and saw the electrical technician. He had been trapped by the elevator car and he appeared to be unconscious. Shortly afterwards, the second engineer activated the general alarm.

The master reported the accident to the refinery operator while the crew tried to free the electrical technician.

Assistance arrived from ashore and, at about 1920, the refinery doctor examined the electrical technician and determined that he was deceased.

The report identifies a number of safety issues, safety action already taken, makes one safety recommendation and issues two safety advisory notices with the aim of preventing similar events.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, risk controls and organisational influences.

Contributing safety factor: a safety factor that, if it had not occurred or existed at the relevant time, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Safety issues can broadly be classified in terms of their level of risk as follows:

- **Critical safety issue**: associated with an intolerable level of risk.
- **Significant safety issue**: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue**: associated with a broadly acceptable level of risk.

EXECUTIVE SUMMARY

At 0024[1] on 26 January 2007, *British Mallard* berthed at the BP Kwinana oil refinery jetty, Western Australia, to discharge a cargo of crude oil that had been loaded at the Laminaria oil field, Northern Territory.

At about 1245 on 27 January, it was reported to the electrical technician that the ship's elevator was not operating. About half an hour later, he and the third engineer tried to rectify the problem. They were not successful but they determined that the second deck elevator landing doors were not closing properly and that this was probably the source of the problem.

At about 1750, the ship's engineers attempted to rectify the elevator problem before they finished work for the day. The second engineer asked if the elevator had been isolated. He was told that it had been isolated and that 'do not operate' signs had been placed at all elevator landings.

The third engineer went to the elevator machinery room. He was instructed to tell the second engineer, via hand held radio, when the landing door relay in the control cabinet was operating. The second engineer and the electrical technician then went to the second deck elevator landing and opened the elevator doors. After making some adjustments to the door switches, the electrical technician stepped onto the ladder in the elevator shaft and asked the second engineer to let the doors close behind him.

Soon after the doors closed, the elevator car started to travel upwards and, after a few seconds, it stopped.

The second engineer tried to open the second deck elevator landing doors and, when he could not open them, he called the third engineer and told him to come to the second deck. The two men then tried, unsuccessfully, to open the elevator doors. They then went down to the third deck elevator landing and opened the elevator doors. When they looked up they saw that the elevator car was near the second deck landing.

The two men then ran up the stairs to the upper deck and opened the elevator landing doors. They looked down and could see the electrical technician. He was trapped between the elevator car and the ladder and he appeared to be unconscious. They shouted to him but he did not respond. Shortly afterwards, the second engineer activated the general alarm.

The second engineer then ran to the ship's office, where he told the master and chief engineer that the electrical technician was trapped in the elevator shaft.

The master then reported the accident to the refinery operator while the crew tried to free the electrical technician.

At 1810, the refinery first aid team arrived on board the ship and, after assessing the situation, they called for further assistance.

At 1842, an ambulance team arrived on board the ship and they took control of the electrical technician's medical treatment.

At about 1915, the refinery doctor arrived on board. He examined the electrical technician and determined that he was deceased.

1 All times referred to in this report are local time, Coordinated Universal Time (UTC) + 9 hours.

By about 0300 on 28 January, the electrical technician had been removed from the elevator shaft and was taken ashore.

The report identifies the following safety issues, makes one recommendation and issues two safety advisory notices aimed at addressing them.

- The ship's elevator instruction manuals did not provide the crew with sufficiently detailed and unambiguous safety guidance.
- The ship's safety management system risk minimising strategies, including the permit to work system and the risk assessment process, were not implemented before the electrical technician started working on the elevator second deck landing door switches.
- The electrical technician, the second engineer and the third engineer were either not aware of, or did not consider, all of the hazards associated with working in the elevator shaft.

1 FACTUAL INFORMATION

1.1 *British Mallard*

British Mallard is an Isle of Man registered double hulled oil tanker (Figure 1). The ship is owned by Jalouise Ltd, operated and managed by BP Shipping, and classed with Lloyds Register (LR).

The ship was built in 2005 by Samsung Heavy Industries, Korea. It has an overall length of 251.56 m, a beam of 43.80 m, a depth of 21.34 m and a deadweight of 114 809 tonnes at its summer draught of 15.023 m.

Propulsive power is provided by a seven cylinder MAN B&W 7S60MC-C, single acting, direct reversing, two-stroke diesel engine delivering 15 801 kW. The main engine drives a single fixed pitch propeller which gives the ship a service speed of 16.5 knots[2].

Figure 1: ***British Mallard***

At the time of the accident, *British Mallard* had a crew of 23 Indian nationals. The mates maintained a watchkeeping routine of four hours on, eight hours off at all times. When the ship was at sea or at anchor, the engineers worked a twenty-four hour duty roster with the engine room unmanned outside normal daytime working hours. When in port the third and fourth engineers maintained a six hours on, six hours off watchkeeping routine, while the second engineer and the electrical technician normally worked between 0800 and 1700 each day.

The master had held a master's certificate of competency since 1997. He had 20 years seagoing experience, with the previous seven years in command. He had been employed by BP Shipping since 2005 and, at the time of the accident, he was completing his second, four month, assignment on board *British Mallard*.

The chief engineer held a class one certificate of competency that was first issued in 1995 in the United Kingdom. He had 19 years seagoing experience, with the previous nine years as chief engineer. He had been employed by BP Shipping since

2 One knot, or one nautical mile per hour equals 1.852 kilometres per hour.

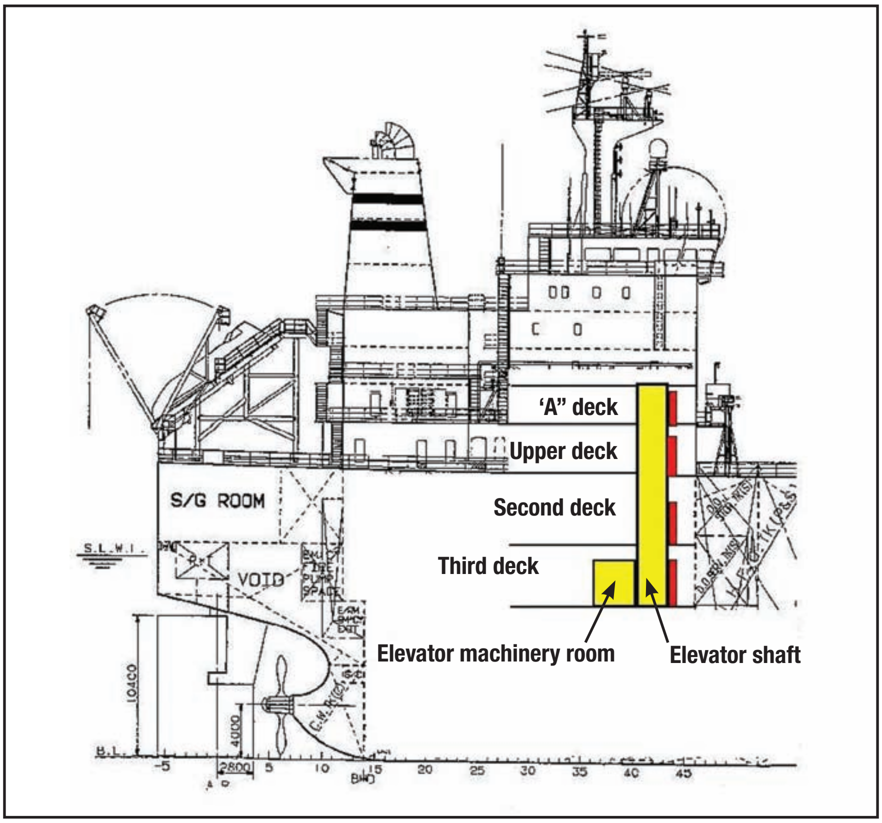
2006 and, at the time of the accident, he was completing his first assignment on board *British Mallard*.

The second engineer held a class two certificate of competency that was first issued in 2001 in the United Kingdom. He had 11 years seagoing experience. At the time of the accident, he was completing his second assignment on a ship managed by BP shipping. He had been on board *British Mallard* for about two months.

The third engineer held a class two certificate of competency and had five years seagoing experience. At the time of the accident he was completing his first assignment on a ship managed by BP shipping. He had been on board *British Mallard* for about one month.

The electrical technician started his seagoing career with the Indian Navy. It was during his 15 years of service with the navy that he received his electrical training. He resigned from the navy in 2002 and he sailed on his first merchant ship in 2003. He had been employed by BP shipping since 2004. He joined *British Mallard* on 31 December 2006 for his second, four month, assignment on board the ship.

Figure 2: Schematic diagram of *British Mallard*

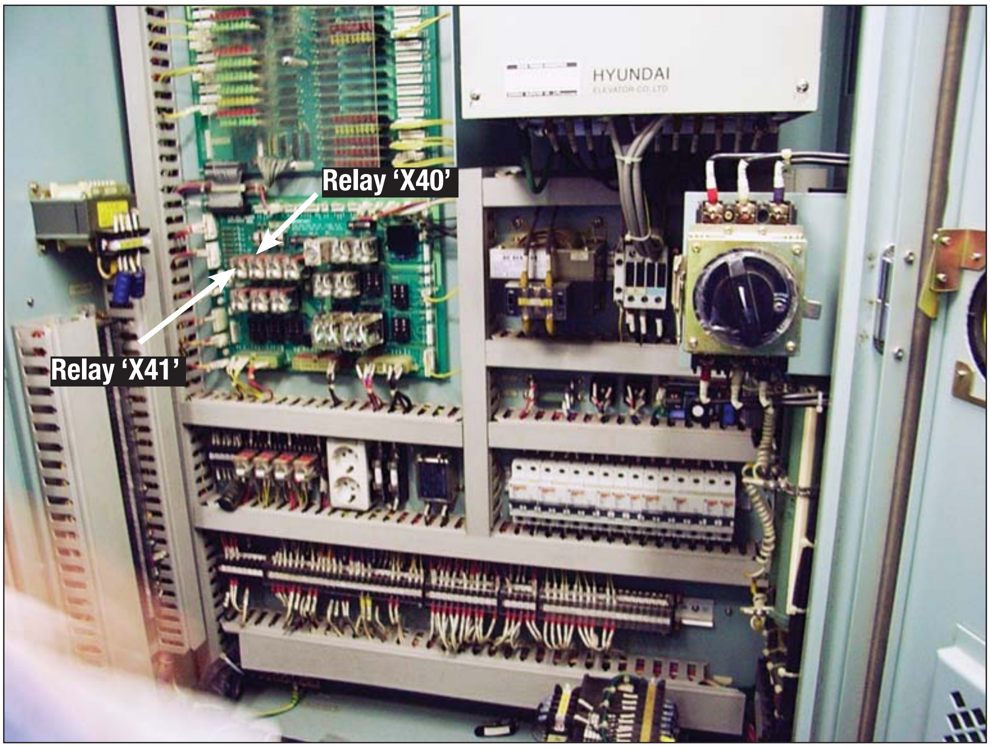


1.1.1 The ship's elevator

British Mallard is fitted with a Hyundai Elevator Company conventional counterweight traction elevator that is rated to carry six persons, or 500 kg. The elevator operates between its uppermost landing at 'A' deck in the ship's accommodation, the location of the ship's office and the engine/cargo control room, and its bottom landing at the third deck in the engine room, the location of the main switchboard room (Figure 2). The elevator also has landings at the accommodation upper deck and the engine room second deck.

The elevator's car is raised and lowered, at a maximum speed of one metre per second, by wire cables that are propelled by an electric motor driven traction machine. The operation of the elevator, and all of its associated safety interlocks, is controlled by a micro-processor control unit. The traction machine and control unit (Figure 3) are located in the elevator machinery room. The machinery room is located in the engine room, on the third deck.

Figure 3: Elevator control cabinet



Each elevator landing has call buttons, which are active when the elevator is operating in the 'automatic' mode. When pushed, they log a call in the elevator control unit's micro-processor. The calls are prioritised and the elevator car responds to each call in turn. If the elevator is not used for a period of 30 minutes, the control unit sends the elevator car to the upper deck.

The elevator control system has electrical and mechanical interlocks to ensure that the elevator car will not move until the elevator landing doors and the car doors are closed and correctly latched. If all the landing doors are not closed and correctly latched within two seconds of the elevator car doors closing, the control unit stops the elevator from operating and cancels all logged calls. The control system will not log any further calls until it is reset, following the correct closure and latching of the doors. The resetting process is automatic and is completed in five seconds.

Each of the elevator doors is fitted with micro-switches that make contact when the doors are closed and latched. When all the landing door switches are closed, indicating that all the doors are closed, an electrical circuit is completed. A relay (X41) then energises, closing a contact which in turn supplies a signal to the micro-processor control unit. Similarly, when the elevator car doors close, another relay (X40) is energised and a signal is supplied to the micro-processor control unit. Each of the relays is fitted with a light emitting diode which illuminates when the relay is energised.

The control system also incorporates emergency stop buttons which are located in the elevator machinery room, inside the elevator car, on top of the elevator car and at the bottom of the elevator shaft. A telephone is also fitted inside the elevator car to provide passengers with a means of communication.

For maintenance purposes there are control select switches located inside the control cabinet and on the top of the elevator car. These switches have two positions; ‘auto’ and ‘inspection’. During normal operation, both switches are placed in the ‘auto’ position. When either switch is placed in the ‘inspection’ position, the elevator only responds to commands received from the up and down buttons located on the top of the elevator car. Furthermore, the elevator only operates while one of the command buttons is depressed. For added safety, the elevator only operates at slow speed when switched to the ‘inspection’ mode.

Amongst the special tools supplied for working on the elevator are an over-ride key and a hand-wheel. The over-ride key is used to unlock the sliding elevator landing doors, enabling the doors to be opened manually (Figure 4). When there is no electrical power supply to the elevator, the elevator car can be raised or lowered by fitting the hand-wheel to the electric drive motor. When the traction machine brake is released, the hand-wheel can be turned in either direction, thereby moving the elevator car either up or down.

1.2 The incident

British Mallard arrived off the port of Fremantle, Western Australia late in the evening on 25 January 2007, with a cargo of crude oil that had been loaded at the Laminaria oil field in the Northern Territory, Australia.

Figure 4: Elevator landing doors being manually opened

A harbour pilot boarded the ship for the passage from sea to the BP Kwinana oil refinery jetty. By 0024 on 26 January, the ship was all fast alongside the refinery's number three berth. The ship's crew and the refinery staff began their preparations for the ship's cargo discharge and, at 0648, the cargo discharge began.

The chief engineer had planned to carry out some main engine maintenance while the ship was in Kwinana, however, he was not permitted to immobilise the ship's main engine. Consequently, the main engine maintenance was cancelled and the engineers concentrated on cleaning the low temperature cooling water heat exchanger, inducting a new crew member, minor maintenance tasks and routine watchkeeping duties.

At about 1215 on 27 January, the third and fourth engineers were in the engine control room, on 'A' deck, completing their watch handover. When they finished, the third engineer left to go to the engine room. He attempted to use the elevator but it did not respond when he pushed the call button. He subsequently used the stairs and walked to the engine room. When he arrived at the second deck, he noticed that the elevator doors were open and that both the up and down call buttons were illuminated. He concluded that the elevator was not operational.

At about 1245, after completing his inspection of the engine room, the third engineer telephoned the electrical technician and reported the problem he had noted with the elevator.

At about 1315, the third engineer was in the main switchboard room when the electrical technician called him on the telephone. The electrical technician was working inside the elevator, at the second deck landing, and the elevator doors had closed behind him. He asked the third engineer to get the manual override key, unlock the doors and open them.

The third engineer opened the elevator doors and he and the electrical technician discussed what the electrical technician had discovered.

The third engineer then held the landing doors open while the electrical technician cleaned the landing door latching mechanism. When the cleaning was finished, the doors were released to check if they would close correctly. However, the doors stopped when they were about two centimetres apart. The electrical technician then asked the third engineer to go down to the third deck and push the elevator call button while he held the doors closed. The third engineer went to the third deck, pushed the call button; and the elevator responded.

The two men then went to the elevator machinery room. The electrical technician opened the control cabinet door and checked the relays inside to see if the second deck doors were still closed. The light on relay 'X41' was not illuminated and this indicated to him that the second deck doors were not closed and correctly latched.

At about 1450, the electrical technician placed 'do not operate' signs at the second and third deck elevator landings, while the third engineer placed similar signs at the upper deck and 'A' deck elevator landings. The two men then stopped working on the elevator because they had other tasks to attend to.

At about 1545, while the engineers were having afternoon tea in the main switchboard room, the electrical technician discussed the elevator problem with the second engineer. The second engineer told the electrical technician to complete both a hazardous work permit and an isolation certificate before he started working on the elevator. When the electrical technician could not find the permit books in the main switchboard room, the second engineer told him to get them from the engine control room.

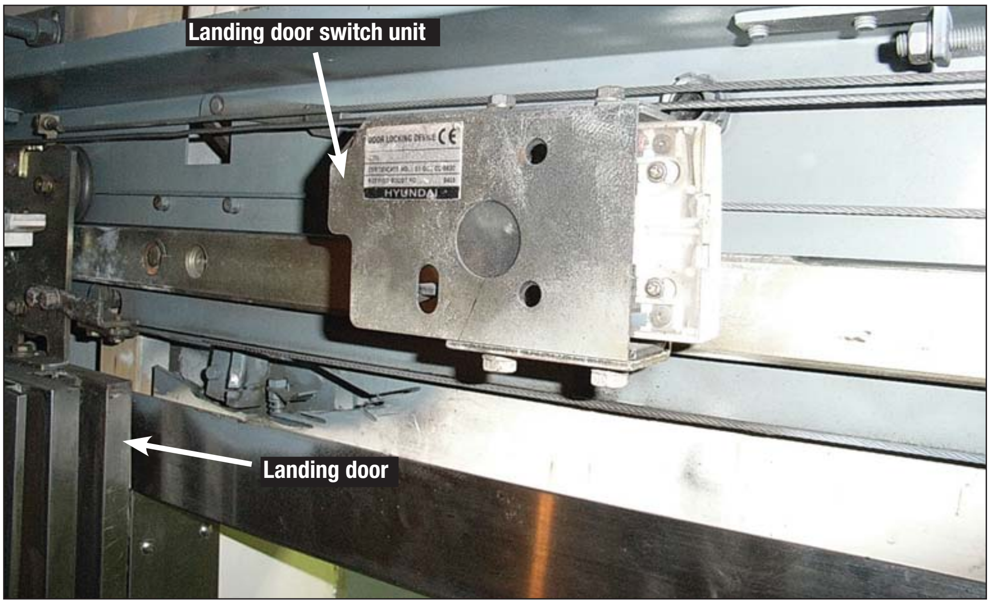
During the afternoon the electrical technician carried on with routine maintenance tasks. He also assisted the second engineer with rectifying a fault in the lifeboat engine starting system.

At about 1750, the electrical technician and the second engineer attempted to rectify the elevator fault before they finished work for the day. Before starting, the second engineer asked if the elevator had been isolated. He was told that it had been isolated and that 'do not operate' signs had been placed at all elevator landings.

The third engineer was asked to go to the elevator machinery room and report to the second engineer, via a hand held radio, whenever relay 'X41' energised or de-energised.

The second engineer and the electrical technician then went to the second deck and manually opened the elevator landing doors. The electrical technician started working on the landing door switches (Figure 5). After making some adjustments to the switches he stepped onto the ladder in the elevator shaft. He asked the second engineer to let the doors close behind him. He also told the second engineer that he would tap on the doors when he wanted them opened again.

Figure 5: Second deck elevator landing door switch unit



About two minutes after arriving at the lift machinery room, the third engineer noticed that the light on relay 'X41' had illuminated. The elevator car then moved in the upward direction for a few seconds. He did not report this to the second engineer because he thought that the second engineer and the electrical technician would have been aware that the elevator had moved.

About a minute after the elevator landing doors closed, when the second engineer had not heard the electrical technician tapping, he tried to open the doors. He could not open them, so he called the third engineer, on his radio, and instructed him to come to the second deck elevator landing. The two men discussed what had happened and then tried, unsuccessfully, to open the elevator landing doors.

The two engineers then went down to the third deck and manually opened the third deck elevator landing doors. When they looked up they could see that the elevator car was near the second deck landing. They shouted to the electrical technician but there was no reply.

The two men ran up the stairs to the upper deck, where they manually opened the elevator landing doors. They looked down and could see the electrical technician. He was trapped between the elevator car door header beam and the elevator shaft ladder (Figure 6). He appeared to be unconscious and only his head, shoulders and one leg were visible. They shouted to him but he did not respond. The second engineer then activated a nearby general alarm manual call point.

At about 1806, just after the general alarm started to sound, the second engineer ran into the ship's office. He told the master and chief engineer that the electrical technician was trapped in the elevator shaft. The three men then went to the open elevator doors on the upper deck, looked down, and saw the electrical technician.

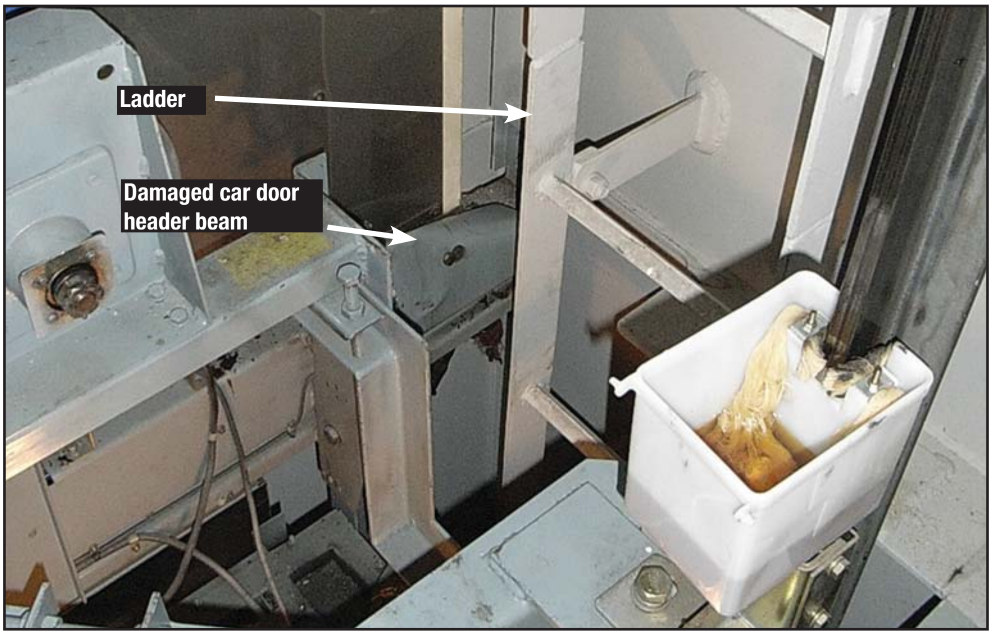
The chief engineer stepped onto the elevator shaft ladder and climbed down onto the top of the elevator car. The electrical technician was unresponsive to the chief engineer and he appeared to be unconscious.

At about the same time, the master reported the accident to the refinery operator and ordered that the cargo discharge be stopped.

The chief mate joined the chief engineer on the top of the elevator car and the two men tried to lift the electrical technician free. However, they could not move him. The left side of his body had been squeezed behind the elevator shaft ladder and his right leg was draped across the top of the elevator car.

After receiving the master's report, the refinery operator organised for the refinery occupational first aid team to assist on board the ship. The first aiders were instructed to assess the incident site and the electrical technician's injuries before passing the information onto the ambulance service.

Figure 6: Damaged elevator car door header beam



At about 1810, the occupational first aid team arrived on board the ship and they were escorted to the incident site. One of the first aiders climbed down on to the top of the elevator car in an attempt to assess the electrical technician's condition. The top of the elevator car was very congested, with three men now standing on top of it, and the first aider could not get close enough to the electrical technician to assess his condition or administer first aid. However, the chief engineer, who was holding the electrical technician by the arm, repeatedly said that he could feel a pulse.

In an attempt to assist in supporting the electrical technician, the first aider organised for a rope to be passed down and for it to be tied around the electrical technician. The free end of the rope was then tied off in the upper deck alleyway. The first aider then climbed out of the elevator shaft.

The chief engineer thought that moving the elevator down might free the electrical technician from his position in the elevator shaft. He instructed the second engineer to fit the hand-wheel to the elevator drive motor and then manually lower the elevator car. The second engineer isolated the electrical power to the elevator machinery and then followed the chief engineer's instructions.

While the elevator car was being slowly lowered, the chief engineer and the chief mate tried to free the electrical technician. However, as the elevator car started to move, the electrical technician slid downwards between the elevator car and the ladder. The lowering of the elevator car was then stopped in order to prevent the electrical technician from sliding any further. Only his head and one arm were now above the top of the elevator car. His right leg had fallen free of the elevator car and was now hanging straight down.

The elevator doors at the second deck landing were now open and a second first aider went down to see if he could reach the electrical technician from that level. He could see that the electrical technician's airway was open and could reach him, but he could not find a pulse. He placed an oxygen mask over the electrical technician's face and connected an oxygen supply.

At about 1842, a team from St John Ambulance, Western Australia arrived on board the ship and they took over the electrical technician's medical care. The ambulance officers carried out an assessment of the electrical technician's injuries. They determined that he had sustained severe injuries to his abdominal region. He was unconscious and the oxygen levels in his blood were extremely low.

At about 1900, the first of a number of teams from the Western Australia, Fire and Emergency Services Authority (FESA) boarded the ship. When they arrived at the upper deck elevator landing, they took control of the area and ordered all of the ship's crew out of the elevator shaft. Two FESA team members then climbed down the elevator shaft ladder and onto the elevator car in order to determine how they were going to free the electrical technician from the elevator shaft.

At about 1915, the refinery doctor and nurse boarded the ship and they were escorted to the second deck elevator landing. The doctor could not reach the electrical technician so he went to the upper deck and climbed down the elevator shaft ladder, onto the top of the elevator car. He examined the electrical technician and determined that he was deceased. The doctor then climbed out of the elevator shaft and informed the master, the ambulance team, FESA and the refinery personnel of his determination.

At about 2040, the police arrived on board the ship to carry out their investigation of the accident. When the police were finished, they requested that the FESA team remove the electrical technician from the elevator shaft.

By about 0300 on 28 January, the electrical technician had been removed from the elevator shaft and was taken ashore.

2 ANALYSIS

2.1 Evidence

On 29 January 2007, two investigators from the Australian Transport Safety Bureau (ATSB) attended *British Mallard* while the ship was at anchor off Kwinana. The master and directly involved crew members were interviewed and they provided accounts of the accident. Copies of relevant documents were obtained, including log books, operating manuals, procedures, permits and statutory certificates.

On 29 and 30 January, the investigators interviewed directly involved BP refinery staff including the occupational first aid team, doctor and nurse.

On 31 January, the investigators returned to the ship and inspected the operation of the elevator with the assistance of technicians from the Otis Elevator Company.

Information was also obtained from the Western Australia Coroners Office, St John Ambulance Western Australia, the Western Australia Fire and Emergency Services Authority (FESA) and the Hyundai Elevator Company.

2.2 The incident

At about 1750, when the electrical technician was preparing to work on the second deck elevator landing door switches, he was aware that the electrical power supply to the elevator had not been isolated. He had probably planned to leave the power on so that he could trace the fault in the elevator control system. His intention was for the second and third engineers to communicate with each other, via hand held radios, while he repaired the door switches. The third engineer was to report to the second engineer when relay 'X41' either energised or de-energised. The relay energising would indicate that the elevator door safety switches were closed and correctly latched.

The electrical technician did not activate any of the elevator emergency stop buttons or place the control select switch in the 'inspection' mode before he opened the second deck elevator landing doors. Therefore, the only mechanism preventing the elevator from responding to a call was the second deck landing door safety switches.

Once the electrical technician rectified the problem with the second deck landing doors, and the doors were closed and latched correctly, the elevator control system reset itself. After the five second reset process the elevator was ready for automatic operation.

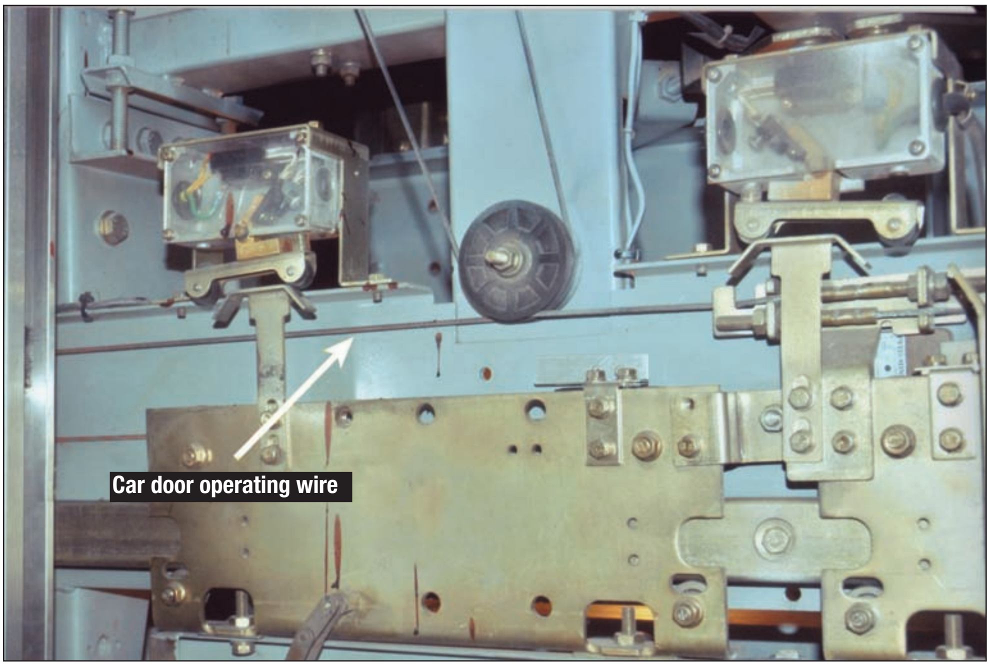
At about 1800, the elevator car moved upwards in response to a landing call that had been logged by the micro-processor control unit. The only possibility is that a call request was made, shortly after the elevator control system had reset itself, following the correct closure and latching of the second deck landing doors. It is likely that someone attempted to use the elevator and did not notice the 'do not operate' signs and was unaware that the elevator was not to be operated.

It is estimated that the elevator moved upwards for about four seconds, giving the electrical technician little time in which to react and evade the moving elevator car. An analysis of the photographs taken by the police indicates that the electrical technician may have tried to climb in behind the elevator shaft ladder (Figure 6) in an unsuccessful attempt to evade the elevator car. Another possible course of action open to the electrical technician was to step from the ladder onto the moving elevator car and then activate the emergency stop button. However, he probably did not have enough time in which to consider this option.

The elevator car stopped just before it reached the second deck landing. None of the emergency stop buttons had been activated and the elevator overload and hoist wire tension safety switches had not been tripped.

While the elevator car was in motion, the car door operating wire held the doors closed (Figure 7). When the car door header beam was damaged, as a result of the accident, it is likely that the tension in the operating wire was released. The release of the wire probably resulted in the car doors opening slightly, enough to activate the door safety switches. The control system then stopped the elevator.

Figure 7: Car door operating wire



2.3 Maintenance manuals

The shipbuilder had supplied *British Mallard* with duplicate copies of the Hyundai Elevator Company's instruction book and system diagrams that related to the ships elevator. The maintenance chapter of the instruction book contained a section titled 'Main Points of Maintenance' which included the following comments in relation to safety and electrical isolation.

> For inspection of electric part, switch off main power working.
>
> For the disconnect switch, mark 'Do not supply'.
>
> For inspection of the moveable part, confirm no working except necessary case.
>
> Build up the habit to turn off the safety switch for the time of no need to move.

These comments give some guidance on the electrical isolation of the elevator but it is not clear or unambiguous. Furthermore, the comments do not give any guidance on the need to, or indeed how to, safely lock out the elevator car while working in the elevator shaft.

While the prime objective of maintenance manuals is to provide accurate technical information, they should also provide detailed and unambiguous safety guidance.

2.4 Elevator safety awareness

An elevator shaft is a very hazardous environment in which to work. The work may be at height, there is the chance of being injured by a falling object, it is noisy and; if the power is not isolated, there is the chance of electrocution from the live elevator electrical circuits. Furthermore, there is the danger posed by the unanticipated movement of the elevator car if the appropriate safeguards are not implemented.

Placing 'do not operate' signs at each elevator landing is not an effective safeguard. While personnel should adhere to the requirements of signage, it does not prevent someone from inadvertently pushing an elevator call button. Similarly, signage alone will not prevent the elevator from responding to a call.

The simplest way to minimise some of the hazards is to isolate the power to the elevator and its control system; and then tag or lock out the breaker. With these precautions taken there is no chance of electrocution from the elevator electrical circuits and the elevator car cannot move.

There are, however, times when it is necessary to enter the elevator shaft while the elevator electrical circuits are live. This may occur when checking the operation of the elevator or when attempting to rectify a control circuit fault, similar to the fault the electrical technician was attempting to rectify on board *British Mallard* on 27 January. In these instances, actions should always be taken to take control of the elevator car before anyone enters the elevator shaft, thereby ensuring it cannot inadvertently move.

There were no procedures in the ship's elevator instruction manuals that outlined how this could be achieved. However, in submission, the Hyundai Elevator Company stated that the crew could have taken control of the elevator by implementing the following procedure.

- Place the control cabinet select switch in the 'inspection' (MCS) position (MCS stands for MaChine-room Slow operation).
- Open the set of elevator landing doors above the elevator car.
- Climb down the ladder and onto the roof of the elevator car.
- Activate the elevator car roof mounted emergency stop button.
- Place the elevator car roof mounted select switch in the 'inspection' position.
- Now the elevator car will only respond to commands made from the elevator car roof control. Even if the car top control switch is accidentally placed in the 'auto' position, the elevator would not be reset. If necessary, the emergency stop switch can now be reset.
- When finished working, move the elevator car to the nearest landing door.
- Open the elevator landing door.
- Place the car roof top select switch in the 'auto' position.
- When clear of the elevator shaft, place the control cabinet select switch in the 'auto' position. If all safety and door interlock switches are closed, the elevator will reset within five seconds.

It is essential that the personnel working on elevators, and in elevator shafts, have a thorough understanding of the elevator control system and its safety circuits. The electrical technician was the most appropriate person on board the ship to be in charge of repairing the elevator fault. He had electrical qualifications and he had previous experience working on the elevator. He had rectified faults with the elevator doors in the past and he was on board the ship when a shore-side elevator technician had previously carried out repairs to the elevator car door operating motor. However, he had not received any training that was specifically aimed at elevator systems and the associated safety practices.

Prior to this accident, BP Shipping had identified the need for their shipboard staff to attend a number of specific training courses. The training courses related to the company's safety management system, particular types of machinery and shipboard systems. However, the need for elevator maintenance and safety training had not been identified.

While the electrical technician was appropriately qualified to fulfil his role on board the ship and he had some experience with the elevator, his actions on 27 January indicate that he may not have been aware of all the risks associated with the task. It is likely that he left the power on the elevator so that he could trace the fault in the landing doors. However, he did not take control of the elevator car, ensuring that it could not inadvertently move, before he entered the elevator shaft.

The processes the electrical technician was following while he was tracing the elevator fault indicate that he had some understanding of the elevator control system. He may also have had an understanding of the possible consequences of entering the elevator shaft and allowing the landing doors to close behind him. It is possible that his eagerness to get the job done before he and the others finished work may have affected his judgement and that he may not have adequately considered the possible consequences of his actions.

Neither the second engineer nor the third engineer questioned the electrical technician's actions or decisions. This indicates that they had little awareness of the risks involved and little understanding of the elevator control system. It is also possible that they considered the electrical technician's actions to be risky but, at the time, they made no comment. They may have considered that, in this instance, the electrical technician had a greater understanding of the risks involved than they did and that they altered their views to match his. This phenomenon is commonly referred to as 'risky shift' or 'group think'.

If any one of the three men working on the elevator on board *British Mallard*, on 27 January 2007, had been aware of, or had appropriately considered, all the hazards associated with the task they were completing, they may have taken the necessary steps to ensure that the elevator car could not move while the electrical technician was working on the second deck landing doors.

2.5 Safety management system

British Mallard's safety management system (SMS) contained detailed procedures and guidelines outlining how the risks associated with hazardous tasks should be controlled and minimised. The risk control strategies included a permit to work system and a task risk assessment process. There were, however, no specific procedures, guidelines or risk assessments that outlined how to work safely in an elevator shaft.

The records on board *British Mallard* contain a number of task risk assessments and many completed work permits. In fact, over 300 'hazardous work' permits were completed in 2006. While the evidence suggests that the systems were frequently used on board the ship, the crew did not carry out a risk assessment or complete the appropriate work permits or certificates before they started working on the elevator on 27 January.

2.5.1 Permit to work system

It was normal practice for the ship's chief engineer to discuss the upcoming planned maintenance with the second engineer two days before the tasks were to be completed. They would consider the need for any special precautions and determine what work permits or certificates would be required. The work permits and certificates would then be filled out and signed by the chief engineer, noted in the bridge log book and posted at the work site before the work was started.

For unscheduled maintenance tasks, such as the elevator repair on 27 January, the crew member in charge was required to evaluate what permits or certificates may be required, complete the permits and certificates and then have them signed by the chief engineer, noted in the bridge log book and posted at the work site.

In general, when a crew member was tasked to complete a work permit they were compelled to carry out an informal risk analysis of the task and to determine what safeguards needed to be put in place to mitigate the risks associated with the task. A senior member of the ship's crew then reviews the safeguards and determines if they are adequate before signing the form, thereby giving permission for the task to go ahead.

Both the isolation certificate and the hazardous work permit are made up of a series of check boxes. The hazardous work permit identified moving machinery as a possible hazard and the isolation certificate made allowance for either electrical isolation or electrical control isolation.

The electrical technician did not complete any work permits or certificates for the elevator repair task. Therefore, he effectively circumvented one of the SMS's risk minimising strategies. He did not take the time to carry out an informal risk assessment and the chief engineer was not given the opportunity to check the safeguards that the electrical technician intended to put in place.

Had all the risks associated with the task been identified, and the appropriate safeguards been implemented, before the electrical technician stepped into the elevator shaft, the accident that followed may have been averted.

2.5.2 Task risk assessment

The ship's SMS task risk assessment process was a more formalised system that was followed when the task under consideration was unusual or deemed to be extremely hazardous. The risk assessment was in addition to the permit to work system requirements and was a tool used to determine, through a structured process, what safeguards should be implemented.

The risk assessment was carried out by a team of suitably experienced personnel. They carried out their assessment and completed a standard shipboard risk assessment form. The form was then checked and signed by the master before the determined outcomes could be implemented.

The task risk assessment was a step-by-step process that started with identifying the hazards associated with completing a task. Once the hazards had been identified, the assessment team had to determine the possible impact of each hazard and the probability of a negative impact. This information was then used to determine the level of risk posed (high/medium/low). The final step in the process was to identify the safeguards that needed to be implemented in order to reduce the risks to an acceptable level.

The ship's SMS did not require an assessment to be carried out every time a task was undertaken. For example, an assessment for working in the elevator shaft could be carried out once and then referred to on each successive occasion that work in the elevator shaft was carried out.

There was evidence to suggest that the ship's crew had carried out risk assessments for some tasks. However, they had not carried out an assessment of the risks associated with working in the elevator shaft.

The appropriate safeguards may have been identified if an assessment of the risks associated with working in the elevator shaft had been carried out before the electrical technician started working on the elevator.

2.5.3 Effectiveness of the system

While there are regulatory requirements that oblige ship managers and owners to implement SMS's on board their ships, there are also benefits to be gained from the introduction of the SMS. One of the main benefits which may be derived from the introduction of a SMS is that it can improve on board safety through the implementation of a set of procedures and risk minimising strategies.

However, it is not enough to simply introduce a system and thereby expect an immediate improvement in safety standards. A culture needs to be developed within the crew that fosters the implementation of, and adherence to, the requirements of the SMS. The ship's crew require ongoing training, managerial encouragement and oversight from the ship's senior staff to assist them with developing the desired on board culture.

One of the key measures used by auditors to gauge the effectiveness of a ship's SMS is the implementation of permit to work systems and task risk assessment processes. These measures give the auditors an insight into the crew's awareness, understanding and adherence to the SMS.

During the engineer's afternoon tea break on 27 January, the second engineer instructed the electrical technician to complete both a hazardous work permit and an isolation certificate before he started working on the elevator. However, at 1750, when he joined the electrical technician to work on the elevator, he only asked if the power had been isolated. He was satisfied with the electrical technician's reply, that there were 'do not operate' signs at all landings. He did not check that the elevator had been effectively isolated nor did he ask to see the permit or certificate and thus he did not ensure that they had been completed.

The third engineer was also working on the elevator and he did not ask to see the hazardous work permit or isolation certificate, or determine that they been completed. He may have considered that it was the second engineer's responsibility to make demands on the electrical technician and not his. However, he should have ensured that the permit and certificate were completed before they started working on the elevator.

The responsibility for carrying out the risk assessment and completing the work permits did not lie entirely with the electrical technician. It was the responsibility of all three men to ensure that the task was completed safely and that the appropriate risk minimising strategies were implemented.

A study of the ship's records shows that this accident was not the only occasion on which the SMS risk minimising strategies had not been implemented. In December 2006, the ship's crew replaced the second and third deck elevator landing door counter weights and, in January 2007, they renewed the oil pots on the top of the elevator car. There were no permits or certificates issued for either of these tasks and an appropriate risk assessment was not carried out.

Had the implementation of *British Mallard*'s SMS been more effective, neither the electrical technician, the second engineer nor the third engineer would have considered working on the elevator without having completed the appropriate permits, certificates and task risk assessment. Had these strategies been in place on 27 January, the accident that followed may have been avoided.

3 FINDINGS

3.1 Context

On 27 January 2007, *British Mallard*'s crew attempted to repair an elevator fault without implementing the appropriate safeguards.

At about 1800, the electrical technician stepped into the elevator shaft and the second deck elevator landing doors were allowed to close behind him. When the doors closed, the landing door safety circuit was completed. The elevator control system then reset itself and, shortly afterwards, the elevator responded to a landing call. The elevator car moved upwards until its movement was obstructed by the electrical technician. The resultant damage to the elevator car allowed the car doors to open slightly, causing the elevator to stop.

From the evidence available, the following findings are made with respect to the accident and should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

1. The ship's elevator instruction manuals did not provide the crew with sufficiently detailed and unambiguous safety guidance. *[Safety Issue]*
2. The ship's safety management system risk minimising strategies, including the permit to work system and the risk assessment process, were not implemented before the electrical technician started working on the elevator second deck landing door switches. *[Safety Issue]*
3. The electrical technician, the second engineer and the third engineer were either not aware of, or did not consider, all of the hazards associated with working in the ship's elevator shaft. *[Safety Issue]*
4. The ship's crew were not supplied with sufficient guidance or instruction that would have assisted them in determining which tasks required a formal risk assessment. *[Safety Issue]*
5. Appropriate safeguards were not put in place to ensure that the elevator car could not inadvertently move while the electrical technician was working in the elevator shaft. *[Safety Issue]*

4 SAFETY ACTIONS

4.1 Safety action taken by BP Shipping

The ATSB has been advised that the following safety actions have been taken by BP Shipping as a result of the accident on board *British Mallard*.

1. On 27 January 2007, all elevators on board ships operated by BP Shipping were withdrawn from service.
2. An updated set of 'Control of Work' guidelines has been issued to all ships operated by BP Shipping. These updated guidelines include a new 'Job Hazard Analysis' process; a hazard identification and risk assessment tool which is to be used prior to undertaking any task, to analyse the type of hazards and level of risk which may be encountered during the duration of the task.
3. The implementation of the new 'Control of Work' guidelines is being backed up by training that includes a DVD which was issued to all ships. Roving fleet safety training officers, line management and the company's safety management system auditors will also be concentrating on the implementation of, and adherence to, this system.
4. A plan for the reinstatement of shipboard elevators was developed and implemented. The comprehensive plan included the following actions:
   - The identification of the hazards present within an elevator shaft.
   - The identification of the need for crews to mitigate these hazards.
   - Defining the entry into an elevator shaft as a 'Hazardous Task'.
   - The development of an elevator shaft rescue and contingency plan by the crew of each ship.
   - The posting of emergency instructions inside each elevator car.
   - Chief engineers taking personal custody of all keys that permit access to an elevator shaft.
   - A thorough inspection of each elevator by an original equipment manufacturer's representative prior to it being returned to service.
   - The introduction of a planned maintenance routine for elevators which includes yearly and five yearly inspections by an original equipment manufacturer's representative.
   - A requirement that all maintenance on elevator safety or control circuits, safety interlocks or other such equipment be carried out by an original equipment manufacturer's representative.

4.2 ATSB recommendations

MR20070023

The ship's elevator instruction manuals did not provide the crew with sufficiently detailed and unambiguous safety guidance.

The Australian Transport Safety Bureau recommends that the Hyundai Elevator Company takes action to address this safety issue.

4.3 ATSB safety advisory notices

MS20070005

The ship's safety management system risk minimising strategies, including the permit to work system and the risk assessment process, were not implemented before the electrical technician started working on the elevator second deck landing door switches.

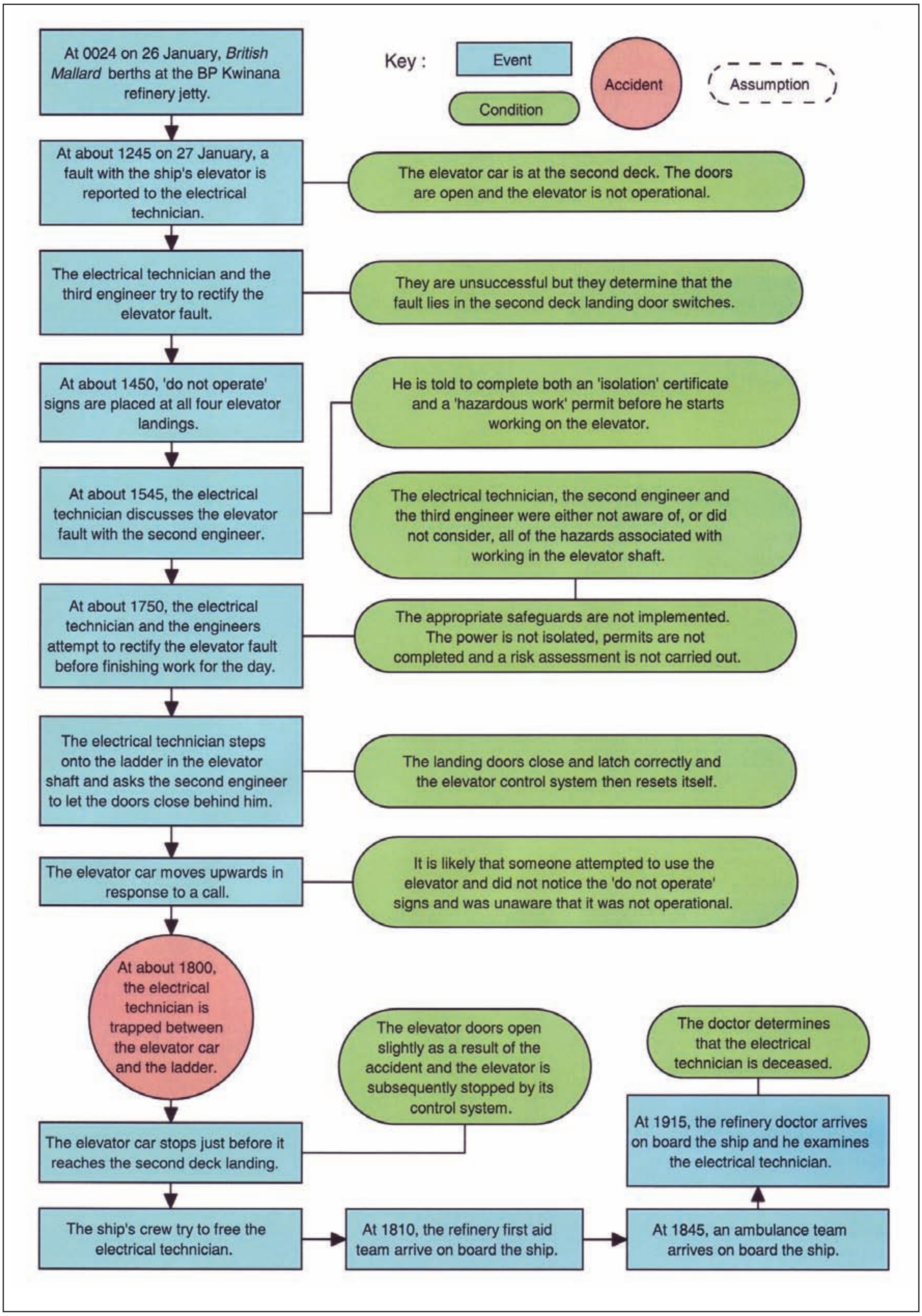
The Australian Transport Safety Bureau advises ship owners, operators and masters to consider the implications of this safety issue and to take action when it is considered appropriate.

MS20070006

The electrical technician, the second engineer and the third engineer were either not aware of, or did not consider, all of the hazards associated with working in the ship's elevator shaft.

The Australian Transport Safety Bureau advises ship owners, operators and masters to consider the implications of this safety issue and to take action when it is considered appropriate.

5 APPENDIX A: EVENTS AND CONDITIONS



6 APPENDIX B: SHIP INFORMATION

6.1 *British Mallard*

IMO Number	9282479
Call sign	MGPU2
Flag	Isle of Man
Port of Registry	Douglas
Classification society	Lloyds Register (LR)
Ship Type	Oil tanker
Builder	Samsung Heavy Industries, Korea
Year built	2005
Owners	Jalouise Ltd
Ship managers	BP Shipping
Gross tonnage	63 661
Net tonnage	34 210
Deadweight (summer)	114 809 tonnes
Summer draught	15.023 m
Length overall	251.56 m
Length between perpendiculars	239.00 m
Moulded breadth	43.80 m
Moulded depth	21.34 m
Engine	MAN B&W 7S60MC-C
Total power	15 801 kW
Crew	23

7 APPENDIX C: SOURCES AND SUBMISSIONS

7.1 Sources of information

The master and crew of *British Mallard*

BP Kwinana Refinery management and staff

BP Shipping

The Western Australia Coroners Office

St John Ambulance, Western Australia

Western Australia Fire and Emergency Services Authority

Hyundai Elevator Company

Otis Elevator Company

7.2 Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003,* the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

The final draft of this report was sent to *British Mallard*'s master, chief engineer, second engineer and third engineer; the BP Kwinana refinery manager, doctor and first aid team; BP Shipping, the Otis Elevator Company, the Hyundai Elevator Company, the Australian Maritime Safety Authority, the Isle of Man Department of Trade and Industry and the Western Australia Coronial Investigation Unit.

Submissions were received from *British Mallard*'s chief engineer and second engineer; BP Shipping and the Hyundai Elevator Company. The submissions have been included and/or the text of the report was amended where appropriate.

8 APPENDIX D: MEDIA RELEASE

Crew member death in ship's elevator shaft

The ATSB has found that the crew on board the Isle of Man registered oil tanker *British Mallard* did not prevent the ship's elevator car from moving while they were working in the elevator shaft and, as a result, it moved unexpectedly, trapping and killing the ship's electrical technician.

The Australian Transport Safety Bureau investigation found that the ship's crew were either not aware of, or did not consider, all of the hazards associated with working in the elevator shaft. The investigation also found that the elevator instruction manuals did not provide detailed and unambiguous safety guidance; and that critical safety procedures had not been implemented.

At about 1750 on 27 January 2007, *British Mallard*'s crew attempted to repair an elevator fault before they finished work for the day.

The electrical technician made some adjustments to the second deck elevator landing doors and, at about 1800, he stepped into the elevator shaft.

At the electrical technician's request, the second deck elevator landing doors were allowed to close behind him. When the doors closed, the landing door safety circuit was completed and the elevator control system then reset itself.

It is likely that someone then attempted to use the elevator and did not notice the 'do not operate' signs that had been placed on the elevator doors and was unaware that the elevator was not to be operated.

The elevator car then started to move upwards. Its movement was eventually obstructed by the electrical technician and the resultant damage to the elevator car caused it to stop.

The ATSB has reported safety action already taken and issued one safety recommendation and two safety advisory notices with the aim of preventing similar accidents.

Independent investigation into the crew member fatality on board the Isle of Man registered crude oil tanker *British Mallard* while berthed in Kwinana, Western Australia on 27 January 2007